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ABSTRACT

The purposes of this research were to: (1) gather information about attributes of methods course teaching that make it more or less effective, (2) compare the perspectives of instructors and students on attributes of effectiveness, and (3) understand more about how university teachers develop an understanding of the thinking of prospective teachers. The data came from two sources: two faculty who observed each other's elementary methods classes, and end-of-course student evaluations. Results from the two faculty are discussed separately. The data of the study seemed clearly to point out that faculty's having a coherent vision of instruction was not sufficient to impact the learning of students. That vision must at least be communicated to students. Without sharing of perspectives, neither students nor faculty gains a full understanding of what the other party is about. (MKR)

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Peer Observation and Feedback as a Component of Self-Study of Teaching by Instructors of Elementary Mathematics Methods

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The purposes of this research were (a) to gather information about attributes of methods course teaching that make it more or less effective, (b) to compare the perspectives of instructors and students on attributes of effectiveness, and (c) to understand more about how university teachers develop an understanding of the thinking of prospective teachers. From 1990 to 1994 we have tried to change the instruction in the elementary mathematics methods course toward "constructivist" teaching (i.e., helping students to develop their own understanding of mathematical ideas) and away from "directive" teaching (e.g., lecture, demonstration of use of manipulatives). It is well known that change is a slow process (e.g., Fullan, 1993), and this research was planned in order to become more systematic in gathering information that might help alter teaching in order to make it more effective.

Theoretical Perspective

The changes in teaching style in the elementary mathematics methods course were prompted primarily by an attempt to incorporate cognitively guided instruction, or CGI, (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989) into the course as a means of helping preservice teachers learn to teach mathematics more effectively. Briefly, CGI is an approach to teaching mathematics in which teachers develop a framework for understanding how elementary students think about mathematics problem solving. The framework includes information about the mathematics of problem solving and the strategies that students use to solve problems. Having knowledge of individual students' thinking allows teachers to adapt instruction to fit the needs of those students. CGI teachers tend to teach in ways that might be classified as "constructivist" in the sense that they help each child build personal understanding of mathematics. CGI research (Fennema, Franke, Carpenter, & Carey, 1993; Peterson, Fennema, Carpenter, & Loef, 1989) has shown that children in CGI classrooms (a) perform better on both standardized tests and problem solving tests and (b) engage in mathematics content at levels far exceeding typical expectations

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of state curriculum guides. In short, CGI appears very effective for helping primary grade teachers teach mathematics in a way that promotes student learning.

One of the guiding principles in our attempt to integrate CGI into the elementary mathematics methods course was that we wanted to model the same approach to teaching in the methods course that is expected of CGI teachers in elementary school classrooms. That is, we wanted to help preservice teachers construct their knowledge of mathematics pedagogy (as opposed to mathematics problem solving) through exploration of children's thinking and through analysis of critical pedagogical questions that face classroom teachers each day. This principle responds to the dictum that "teachers teach as they were taught," in that we wanted to be sure that they experienced as learners the opportunity to construct knowledge - in this case, knowledge of mathematics pedagogy rather than knowledge of mathematics. At the same time, we were moving away from "propositional knowledge" about mathematics teaching as the main outcome of the methods course and toward more reflective decision-making as the primary goal (e.g., Stengel & Tom, 1996, p. 596). This potentially put us in conflict with the outcomes sought by the students in the course.

> Who you are shapes what you want for your students -- that is, your objectives. Who they are shapes the particular "course of study" that will enable you and them to achieve these broadly conceived objectives. ... Curriculum is dependent both on who students are and what they already know and on how teachers understand their task as well as how they understand themselves. (authors' emphasis, Stengel & Tom, 1996, p. 600).

Further, the images of teaching that the students brought to the methods course potentially created conflicts with the goals of the course.

> Preservice teachers often have well-rooted images of themselves as teachers and high ideals and aspirations for teaching, and they strive to enact or play out their personal images despite contextual realities that are often at odds with them.... Now, it is quite widely accepted that formal teacher education has an important but secondary influence on teachers' thinking and practice, the latter being indelibly imprinted by life, school, and career experiences prior to entry to formal programs of teacher preparation. (Knowles & Cole, 1996, p. 654).

The attempts to revamp the elementary mathematics methods course were within the context that preservice teachers consistently claim to be more influenced by what they see elementary teachers do than what they see methods course instructors do, even though this influence can be negative relative to attainment of the goals of a teacher education program (e.g., Guyton & McIntyre, 1990). Yet, we hoped that by focusing the content of the course on children's thinking and by encouraging the preservice teachers to construct their own knowledge of pedagogy, we

might help them take up the mantle of contructivism in their own teaching, regardless of whether their cooperating teacher in student teaching did so.

Method

The data came from two sources. First, as colleagues who taught different sections of the elementary mathematics methods course in Spring 1995, we agreed to observe each other's classes and to "debrief" those observations during taped interviews immediately after each class. (Each section met once per week, for three hours per session.) The tapes of these debriefing interviews were transcribed by a third person who had no knowledge of the course. Interviews lasted from 45-90 minutes. Because of scheduling, the number of observations and interviews were slightly different for the two faculty. One person (referred to as "Faculty A") was observed six times, totaling about 16 hours (three consecutive weeks in February and three consecutive weeks in April). In five cases, the debriefing interviews occurred immediately following the observations; in the sixth case the debriefing interview occurred on the day following the observation. The other person (referred to as "Faculty B") was observed four times, totaling about 12 hours (two consecutive weeks in February and two consecutive weeks in April). All debriefing interviews occurred immediately following the observations. No one other than the two authors were involved in the data gathering. That is, the faculty generated data about themselves without involvement of anyone else.

The transcripts were read and segments were identified that seemed to represent coherent "chunks" of dialogue, each of which focused on a single underlying theme (e.g., development of mathematical knowledge, development of pedagogical knowledge, affective concerns of students). For each interview, these chunks were then entered into a table and each chunk was coded according to the theme. The chunks that represented a common theme were then pulled out of the transcripts into a new table for further analysis. Throughout this process, Faculty A coded the interviews that were conducted after each observation by Faculty B, and Faculty B coded the interviews that were conducted after each observation by Faculty A. Future analysis of the data is expected to involve having each faculty recode (or at least review the coding of) the other faculty's "data."

The transcripts provided data concerning inferences made by either faculty about (a) positive or negative reactions of students during the class, (b) ways that students' thinking were revealed through their actions and verbalizations during class, and (c) the faculty member's instructional strategies, including pace and types of questioning. The themes that emerged were inferences about the nature of what was happening during the observations. That is, key points in the faculty dialogue involved explicit mention of when particular knowledge seemed to be developed on the part of the students or when specific issues seemed to surface during the observations.

These inferences were based on two primary factors: (a) positive or negative reactions (including body language) of students in the class and (b) ways that students' thinking were revealed through their actions (e.g., use of manipulatives) and verbalizations during class. Of particular interest for this study were times when one or both of the faculty inferred that a particular instructional event was effective or ineffective in helping students learn about mathematics content or mathematics pedagogy.

Second, the end-of-course evaluations by the students were examined. These evaluations included quantitative responses (e.g., Likert items) and individual written comments. The comments were examined to identify characteristics of teaching that the students viewed as particularly helpful or not helpful for their learning. Students' comments were particularly useful in determining what students identified as helping or interfering with their learning.

Description of the Classes

There were 33 students in Faculty A's section, 31 female and 2 male. One of the female students was hearing impaired so a signer was present during all class sessions. Faculty A had no contact with these students other than the methods course. Faculty A held certification at the secondary level in mathematics but had worked over many years with inservice elementary and middle grades teachers. As part of this work, Faculty A had observed in many elementary school classrooms and had conducted demonstration lessons at a variety of grade levels.

With the exception of two special-education majors, the students enrolled in Faculty B's methods course were members of an elementary-education cohort led by Faculty B who also served as the students' adviser. At the time of the mathematics methods course, Faculty B also taught the students' inquiry seminar and supervised their 10-hour-per-week internship experience in an elementary classroom. Similarly, during the previous semester she also taught the students' inquiry seminar and supervised their related 10-hour-per-week internship experience. This faculty-student relationship that existed beyond the methods class may have had an effect on some of the discussions that occurred during class sessions because Faculty B had first-hand knowledge about the mathematics instruction which the preservice teachers were observing in the internship setting. In addition, Faculty B's professional background included several years of experience as an elementary-school teacher. Thus, she had many personal teaching experiences that she could draw upon as part of her instruction.

Results and Discussion

The data for each faculty are presented and discussed separately. Later in the paper, there are general conclusions that seem to apply to both sets of data.

Faculty A: Results

Several areas of concern surfaced in the data. Three of these are discussed here: (a) questioning and feedback, (b) affective issues, and (c) development of pedagogical knowledge.

Questioning and Feedback. Instances in which Faculty A followed-up on students' responses with probing questions were discussed explicitly several times in the interviews as illustrations of constructivist teaching. Too, Faculty A intentionally tried not to provide right/wrong evaluation of the substance of what students said but rather only of the clarity of how they expressed their understanding.

> Faculty B: I also liked the exchange where [Student A1] could not come up with a response to the question and so you asked somebody else the question. I thought that's a neat idea.... And then [Student A2] asked a question and then you directed it back to [Student A1] and I thought that's a nice dialog to have in the classroom. I've done that. I've done it a little bit but not to that point.
> Faculty A: I don't know much about [Student A1's] thinking yet. But my sense from listening to him ... is that he is confused a little bit and he has trouble expressing himself. But I don't know whether it's because he doesn't know the mathematics or whether it's a language difficulty or what the problem might be.
> Faculty B: He seemed comfortable with how it all worked out.
> Faculty A: Yes. He did. It took the spotlight off him for a minute. I sensed that the spotlight might be a little bit too extreme right then. So he got to pick on a friend. *(January 30)*
>
> Faculty B: There was a good question in there to get them to think about their understanding.
> Faculty A: Some of them are obviously, at least at the beginning of the class, were obviously unprepared to tell me what they were thinking. As if, I know how to do it but I haven't had to think about it in so long, I can't tell you how to do it. I don't have to think about this. *(January 30)*
>
> Faculty B: And then a student was holding her hand up and you said hold on and how did you know that she might have been going to give some kind of answer to the question ... you continued then to respond. What if she had been going to respond?
> Faculty A: I didn't know. But it's one of
> Faculty B: And this comes back to my question about how far do we take constructivism?...
> Faculty A: I made a decision at that point that the conversation we were having was the time to make a point and I wanted to be sure the point got made before we got diverted into something else. So I just wouldn't take the risk that the student whose hand was up was going to ask something extraneous so that was an authoritarian teacher decision. I want to be sure this gets said. *(January 30)*
>
> Faculty B: There were good questions today. The class seems very comfortable in asking questions....
> Faculty A: Yes. They were good questions. *(February 06)*

Faculty B: And you know, I think also, there was a lot more talking today.... A lot more hands went up in responses to your questions.... I took down notes but it was more about questioning. I thought it just went very well today. There was a lot of interactions, a lot of good probing, they were being forced to say specifically what they were thinking and accepting it readily. *(February 13)*

Faculty B: But in some of their behaviors and mannerisms, there is definitely a change.
Faculty A: Yes, there is a change. They are more willing to take a position and not give it up just because it's questionable. And of course early in the semester, they thought that I was after them to give up their views just because I was asking them questions and now they know that's not what I'm doing. So they certainly have learned enough about me to know that they can have a position and hold on to it. *(April 06)*

Faculty B: And [Student A3] also liked this class session yesterday.
Faculty A: Did she tell you why?
Faculty B: One of the reasons was the questioning was so good on your part. And it didn't make her feel intimidated in any way. *(April 06)*

Faculty B: [Class today] was more of a workshop approach, you were being more of a facilitator, in a sense, than in some previous lessons where you ... were focusing more on extending their own knowledge and understanding of the mathematical concept involved. And when you get into that kind of questioning, it's a little more threatening to them.
Faculty A: The whole atmosphere was more relaxed yesterday ... more friendly. I was aware of that change.
Faculty B: And see I'm not saying that's good or bad. I am not raising that at all. *(April 06)*

Faculty B: I am wondering with the "I understand it" how much that singles you out as the ...
Faculty A: Partly as the authority. It does have that effect.
Faculty B: The evaluator, that they are really doing it for you. I don't think this really came across except I heard it so much today and I haven't heard it before.
Faculty A: I don't intend it to come across as evaluating. If it comes across that way, then I need to do something different because I am explicitly not trying to evaluate.
Faculty B: I think it may have an evaluation connotation because "I understand that", that means, okay, you did a good job explaining it. I mean it could be interpreted that way.
Faculty A: That doesn't mean the explanation is mathematically correct.
Faculty B: But they interpret it as being ... you know, you know how little kids are if you don't respond to them, they think they got it wrong, if you ask them how they did it, they think oh I must have gotten it wrong because they ... you know how teachers always give them the correct answer and when they start asking questions, they think there must be something wrong with this. I think that's somewhat analogous to this that saying "I understand that" is interpreted by them as "It's okay, it's correct."
Faculty A: I don't intend it to be that at all.
Faculty B: Then you might want to think about that some because that's how I interpreted it. *(April 24)*

The probing questions seemed to be viewed by students in their end-of-course evaluations either as helping them assess their own thinking or as putting them on the spot and making them feel threatened.

> The instructor is very knowledgeable, uses hands-on methods and seems excited about his subject. However, his personality had an effect on the course.... His first few days of instruction included questioning students and making them feel very uncomfortable. He did, in a later class, address this level of uneasiness, which was commendable.
>
> Whereas I have been challenged to explore my knowledge base of mathematics, ... I do not feel prepared to teach elementary math.
>
> Students were forced to think about and question their views on issues.
>
> He did a good job keeping us interested, but occasionally made us uncomfortable by pushing too hard for answers.
>
> He is an excellent teacher and encourages all students to be involve (sic). He listened to questions and answers very well.
>
> I often felt intimidated in class and I also felt that I was not given enough time to think on my own.
>
> He often conducted class in a way that made us feel uncomfortable and afraid to answer questions. He probed our answers excessively.
>
> The professor did not give positive feedback; he was rude, demeaning, and talked about items until they were tiring and overdone. I felt embarrassed and intimidated a lot of time due to his critical manner.
>
> The instructor rarely "point-blank" answered our questions, and even engaged students in confrontations with one another when their viewpoint differed so that he would not have to give an answer.
>
> Students were made to feel humiliated by the instructor on many more than one occasion. We were probed for justification of our answers, but usually not given feedback as to whether were right, wrong, or even close.
>
> The instruction in this class is too stressful. I know that the goal is to get us to completely understand the material. This requires asking the question "Why?" We were too frustrated and stressed out from the rigorous probing at times, that we just gave up and decided not to put in input. I left this class physically drained a couple of times because of the frustration.
>
> He often dodged questions asked by students. The classroom atmosphere was confrontational and tense.
>
> Too much probing.
>
> He often forces students to try to answer questions when they cannot or continues the inquiry/discussion until they become frustrated and lose interest.... More thorough explanations of why we are doing what we are doing and how activities apply to the teaching of mathematics would greatly improve the quality of instruction.

Affective issues. Affect issues were discussed explicitly in each of the six interviews. In the first interview (after observation of the second class period) the faculty commented on the fact that students appeared not to feel threatened by the amount of material covered.

> Faculty B: I agree with you. I think the pace was good. They were not threatened in any way either.

Faculty A: I did not sense they were threatened as my students sometimes do get and I am trying not to do that as much. So from that perspective I think the class went well. *(January 30)*

During February 6, there was another comment about what teachers are willing to allow; this may indicate the level of uncomfortableness of students:

Faculty A: And I know that all kinds of teachers, both pre-service and in-service do get very uncomfortable when the child gets uncomfortable and they won't stay with the child if they sense the child is becoming uncomfortable, even though cognitively it might be a good thing to do.
Faculty B: Right, it's the emotional part.
Faculty A: Yes. But the affective part really dictates what teachers are willing to do, it seems to me. *(February 06)*

During the third class period (second observation), one event occurred which seemed to be pivotal in the ways that students viewed the quality of instruction. One student was asked a series of questions about her solution to a specific problem. She did not solve the problem correctly, and she struggled with trying to explain her thinking. Several excerpts from the interview after this observation gives a sense of the interpretation of this event by the faculty.

Faculty B: The one thing that I do find a difference in us and I don't know if that is what we are looking for here, that I found myself thinking a lot in terms of evaluating myself was the perseverance that you have in questioning an individual and keeping on questioning. And it was the case with [Student A4].
Faculty A: And you were sitting next to [Student A4]. I spoke to her during break. I thanked her for staying with me on all of those questions. That's the sort of thing that I do that makes students very uncomfortable with me.
Faculty B: Well, you know ... I don't ...t here are a couple of points there and this is what I found myself thinking about. Cause when you are in the back of the room and you have time to observe and think, it's much different than when you are up on the stage. And I found myself wondering, how was [Student A4] feeling in the situation? She was handling it all pretty well. She was...she didn't want to keep on doing it, but she did, and then the person that was sitting on her left.... But what I did have a reaction about was not so much how was [Student A4] feeling in this situation because clearly it was challenging [Student A4] to higher level thinking...I mean it was challenging her, not necessarily higher level thinking, but challenging her own understanding of it and patience and keeping the stress level, but at the same time, how were the others reacting about [Student A4] being in that situation.
Faculty A: Ah, I have no clue.
Faculty B: Yes. And they were all very patient, but I'm sure a lot of them wanted to help her out. And I don't know if any of them were feeling uncomfortable themselves because of this situation that [Student A4] was in.
Faculty A: My guess is that there probably were some who probably were very uncomfortable because they don't normally see a student put on the spot like that.
Faculty B: Right.

Faculty A: I have mixed feelings about doing it. Obviously, I think it's important to do, but it does cause a negative feeling...it can cause a negative feeling in the class about me harassing students and I certainly have to try to avoid those feelings from developing. *(February 06)*

Faculty B: But at the same time, in the process, [Student A4] is not going to forget that. [Student A4] is going to have a better feeling about herself and a better feeling about her own understanding and I think she is going to know that a little bit better than if she had been sort of let off the hook, so to speak, and somebody else had helped her out. So I think there is real benefit in it. *(February 06)*

Faculty A: Last fall in the [other] methods course ... the students in that class had felt like I was picking on them.
Faculty B: See, I didn't get a sense of that.
Faculty A: I don't think I did that today.... I think I did go away from her soon enough. And I did come back to her. I didn't come back to her quite soon...quite as quickly as I had wanted to. ... But then, that gave me a chance to come back to [Student A4] and in some sense bring closure to that interaction. So that I don't think it was too upsetting to too many people, but I am aware that that kind of pedagogy can cause students to be very uncomfortable. *(February 06)*

Faculty B: Instruction needs to be based on the individual needs of the student and as teacher your goal is to find out what your students know. And in a sense, that could put her more on the spot, like I am trying to find out what [Student A4] knows here. But a part of it is that you are going to ask those questions and you are going to try not to put them in an uncomfortable position. You certainly wouldn't do that if you felt [Student A4] was uncomfortable. You didn't feel that and I didn't feel that.
Faculty A: I knew she was uncomfortable but I didn't think it was at a level where it was detrimental.
Faculty B: No. I didn't see that either.
Faculty A: Any student who is asked four or five questions is going to feel uncomfortable. *(February 06)*

At the beginning of the next class, there was a discussion about how each student had felt during the extended interaction with Student A4. (Student A4 was warned before class that this discussion would take place, and she agreed that it might be helpful.)

Faculty A: The opening discussion was important.
Faculty B: Yes, it was.... Wasn't their candor kind of ... I found it very encouraging that they felt very free to express their thoughts to you and not easy things to express.
Faculty A: That's true.
Faculty B: But I think it's a nice indication they felt comfortable doing that. *(February 13)*

Another area of concern expressed by the students was that they wanted the instructor to tell them whether their answers were correct. One part of the philosophy of instruction, perhaps only

implicitly modeled, was that teachers, both inservice and preservice, need to make their judgments about whether their views are correct or incorrect.

> Faculty B: We had such a discussion at our table. She [a student] was to a point she was questioning herself, too. Was she correct about it. She didn't want to say it ... she didn't want to share. She said, I don't want to look stupid. That was her very words.
> Faculty A: Did she say that at the table?
> Faculty B: Yes, well, sort of to me.
> Faculty A: I hope she didn't feel like she did look stupid because I didn't sense that at all. It's a wonderful problem. *(April 10)*

One of the continuing inferences by Faculty B was that the amount of talking that students did represented their level of comfort.

> Faculty B: Did you notice how they talked about more as they felt more comfortable about their own thinking. In the very first part they didn't talk very much. *(January 30)*

> Faculty B: And then the group at the table next to me while you were working with Wendy, they were talking so absolutely soft, but then they all began to open up and by the last half of the class session, they were really doing a lot more talking, a lot more sharing, a lot less apprehension. *(January 30)*

> Faculty B: And you know, I think also, there was a lot more talking today, whether that had anything to do with it or what, I don't know. A lot more hands went up in responses to your questions. *(February 13)*

> Faculty B: They are much more confident than they were at the beginning of the semester. They are willing to argue with you about things.... They are also more involved in making sure they understand it or that their peer understands it so some of that talking that was taking place was they were trying to help each other. And in the process didn't realize they were distracting the rest of the class. But also it was like they knew and they could tell others. There was a sense in terms of this level of self-confidence that I see as a change from the first group. *(April 10)*

Yet, in the end of course evaluations, students specifically commented on the way that the first few classes were conducted as a contributing factor to their negative view of the quality of instruction. In general, students' perspectives seemed to be dominated by their sense of "class atmosphere." Their view of mathematics seemed to be that the teacher is the authority of correctness and must assume that role. Too, they wanted to be shown mathematics lessons that could be directly transported to their own teaching rather than to develop a framework for understanding mathematics pedagogy. This particular difficulty may have been made more intense by the fact that cooperating teachers who supervised the internship experiences during the methods course were not CGI teachers. Thus, the preservice teachers did not see much in

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their classroom experiences that was consistent with the major thrusts of the mathematics methods course.

> His first few days of instruction included questioning students and making them feel very uncomfortable. He did, in a later class, address this level of uneasiness, which was commendable. The quality was excellent in what was taught, but choice of material and student interaction left something to be desired.
>
> The quality of some of the material was good but I wish that we would have learned more about actually how to teach math. We needed more innovative, practical, and hands-on ways of teaching.
>
> Several activities were given to use with students, however, the primary focus was understanding how and why children think the way they do.
>
> I do not feel that the instruction I received is going to be very resourceful when I enter the teaching field. I did not receive any instruction about teaching lessons and practical applications for the classroom. This should have been the emphasis for this class - not assessing students' mathematical thinking.
>
> I feel that we wasted a lot of time in this class. I was hoping to be able to gain insight on math in the elementary school. I do not feel prepared to go into the classroom and teach math based on what the instructor has taught us.
>
> I do not feel what was taught will adequately prepare me to teach math.
>
> I don't feel that learned what I needed to teach elementary mathematics.
>
> The instructor did not teach us how to teach math. He taught us to assess math knowledge in children and we re-learned some concepts in math.... We learned more about researching thinking than we did actual teaching.
>
> The bad thing is I'm not seeing this type of math instruction in the school setting, and it would be difficult to apply unless children began this method of learning from the beginning.
>
> This is suppose (sic) to be a math methods course. We are suppose (sic) to be taught how to teach math. The underlying principles of why things are the way they are in math are important but are not the only important thing. We recieved (sic) little to no instruction on teaching math to elem. children. We recieved (sic) no instruction in teaching math and practical applications for the classroom.
>
> The instructor did not teach us how to teach math. He taught us to assess math knowledge in children. We learned more about researching thinking than we did actual teaching.
>
> For example instructions on how children think about math were given but not on how to teach children math.
>
> I feel a lot of time and my money has been wasted, it has not prepared me to teach math in the elementary schools. We did not ... get any activities that can be used to teach math.
>
> I didn't think this class was a methods course. I did not learn how to teach math in this class. I now know how a child thinks and processes things but as far as how to teach the subject area I have no idea.
>
> I do not feel that the instruction provided in this course has prepared individuals to teach math in a realistic classroom setting.
>
> We were never given ideas for math lessons or even general explanations of how to teach math concepts.
>
> I wanted more practical suggestions on how to teach math. I wanted to learn how to teach math to elementary kids and I don't feel like I got specific suggestions except twice.

Development of pedagogical knowledge. The development of pedagogical knowledge was a recurrent theme in Faculty A's discussions during the interviews.

> Faculty A: One of the difficulties I have in methods courses is I am not clear enough with students about what we are doing that is for us as adults and what you do you kids as kids. And I suspect that most of them walked away today believing that you would do number sentences with kids. And I really wouldn't want that to be the predominant way of dealing with kids. *(January 30)*
>
> Faculty B: That might be a means of your way of reinforcing the fact that ... a lot of teachers have preconceived ideas.... Children see it differently.... [Teachers] just automatically know how to do it themselves.
> Faculty A: Ah, and kids don't.
> Faculty B: And kids do not. As a teacher you can't assume they are going to think the way you are thinking or whatever. But you also can't impose your thinking on them.
> Faculty A: Right. Not only do they not think the way you do because you don't have to think about it and they do. They don't do it the same way that you do it so you are dealing with a mismatch in process as well as processing. *(January 30)*
>
> Faculty A: I was focusing today when I asked them to write story problems, but I was focusing on their own understanding. But again I think it's through concerns of pedagogy, how do you make up problems? They struggle so hard with making up problems that I really think they need lots of opportunities to make up problems. *(April 10)*
>
> Faculty A: It reinforces [the] comment about videotapes as being still powerful examples - such powerful examples that teachers want to copy them, rather than make sense of them....
> Faculty B: That's right.
> Faculty A: ... The role of samples or examples in helping novice teachers understand what's going on really becomes suspect. *(April 10)*
>
> Faculty A: Well, they are trying to do the activities. They are not looking at it from a pedagogical point of view or a content analysis point of view. They are just trying to answer the questions so they miss all of the other stuff that's behind the activities that as teachers they might ... be able to see. *(April 18)*
>
> Faculty B: I am not so sure how much they recognize that as a teaching strategy themselves, and how with these activities, all that you can cover. I am sensitive to this because that is what I am trying to do in my class, is to let them see that one activity can address several different objectives.
> Faculty A: But it would also be useful to point out that ... it's because we have done work on fractions and ratios that you can use ratio here. You know, you've prepared for it....
> Faculty B: Yea. It also would address the fact that as they are working with their students and they want to come back and visit previous things they have addressed in their class, they can do it through an activity like this and then they will know their students better because it's a day by day basis and they can find out those that have retained the knowledge and those who haven't and those that need some further instruction. *(April 18)*

Faculty A: Before you came in today, we debriefed last week and I am sorry you missed that except it was not a very interesting discussion. Their memories of last week were not very vivid.
Faculty B: Isn't that interesting.
Faculty A: It surprised me.... I expected that there would be some discussion and there really was very little discussion and they had to work to bring back what we had done last week and they remembered doing activities but then we had listed, at your suggestion, we had listed the mathematics objectives for the content that could have been addressed, that were addressed by those activities and of course, they left out the important ones like problem solving and communication and reasoning until the very end. They kept talking about measurement and metrics and area and perimeter and those are very good but I said you have missed the most important ones. And I mentioned the Standards again and I said you have read the Standards, they are in your handout and then somebody said, oh, problem solving, and then somebody said, oh, yes, communication and so we got those out and I had made a point of those being important and that's really why I made the same point on reasoning. *(April 24)*

Faculty B: Today's class was different than some I have sat in on because it was their own mathematical thinking, a lot of that. And I sat there wondering, I wonder if any of them are thinking, how can I use this with students, with elementary students?
Faculty A: I doubt many of them were.
Faculty B: I'll bet it didn't cross too many people's mind. ...
Faculty A: And we did talk curriculum and objectives today and those kinds of things so in that sense, there was pedagogy talk, but there was not really any discussion of the design of the lesson, which was very carefully put together. I mean very, I won't say carefully, it was very consciously put together. And the sequencing of the problems was very deliberate. *(April 24)*

Faculty A: Discussion

It appears that in order for Faculty A to teach mathematics methods effectively to preservice teachers there need to be changes in teaching style. First, some things need to be made more explicit: objectives for the course, expectations of students in the course, the reasons for the particular style of teaching, etc. This presumably can be done through discussions during the early part of the semester and through handouts addressing each issue. The instructor's philosophy of teaching probably needs to be made more explicit; hopefully students will suspend judgment about whether this philosophy is effective until toward the end of the semester.

Second, more explicit attention needs to be given to helping the students develop their skills and confidence at helping children learn mathematics. It seems important to have discussions of why "presenting information" is effective or ineffective at helping children learn mathematics. This point is intimately tied to students' notions of what mathematics is. If they view mathematics as procedures then presenting is one obvious instructional technique, but if their views can be expanded to focus more on problem solving, then presenting is probably not an effective techniques. Relatedly, students probably need to be helped in being able to reflect on

their own learning during the course, especially in light of how classroom events seem to impact what they learn about mathematics content and mathematics pedagogy.

Third, differences between the pedagogical approaches espoused in the course versus the approaches implicit in the teaching of cooperating teachers need to be highlighted and discussed. In particular, there needs to be more explicit discussion of the ways that a teacher's understanding of children's thinking can impact both the planning and the execution of instruction. It is not clear whether discussion of the methods course instructor's planning and execution of instruction is the proper vehicle for this discussion. Rather, the discussion may need to be focused on elementary teachers' instruction with children.

Fourth, the mathematical learning needs of children need to be highlighted. Necessary changes in mathematics instruction that are driven by technology and other factors need to be discussed and illustrated more explicitly. The differences between the "reform view" of mathematics instruction and the previous mathematics instruction of the students in the methods course need to be discussed and justified. Such discussions might help provide a rationale in support of reform.

Faculty B: Results

The data revealed that a major concern for Faculty B was helping preservice teachers develop and extend their pedagogical knowledge. In particular, she focused on providing appropriate experiences during class that would help the preservice teachers make "connections" to what children would do in the same or similar situations and how teachers can use the knowledge gained from those activities to provide instruction that meets the mathematical needs of all students.

> Faculty B: I want [the preservice teachers] to realize that ... their most important role is that they have to learn what their children know. Children's thinking is the crucial thing, not what the teacher thinks and what the teacher believes [the children] should be doing, but the teacher needs to know what the children understand or think and then [fits] the instruction to meet that .... Pedagogy is very, very important, I think, and often gets neglected in methods classes because we make assumptions that they know this or they can do this.
> Faculty A: Or ... they can take what we do and figure it out.
> Faculty B: Yes, they can take what they are experiencing and make it work. I cannot expect that. *(March 1)*

Faculty B's emphasis on pedagogical knowledge seemed to affect the topics of discussion following each observation. The interview discussions often focused on (a) the type of instruction provided during the mathematics methods course, (b) the preservice teachers' thinking and understanding, (c) the amount of "wait" and talk time, and (d) the dilemma of not having internship classrooms that provided models of what was being advocated in the methods course.

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Instruction provided during the methods course. Discussions about the type of activities or instruction provided during the methods course centered around what the instructor did during a session and why, what the instructor could have done differently, or what should be included as part of the methods course.

> Faculty B: As long as I have been teaching, I have never taught the way I taught today.
> Faculty A: How was it different?
> Faculty B: I was trying to focus ... more than I have ever done before on their role as a teacher and what this all means. It is one thing [for a teacher] to know the problem types and to ask the students their solution strategies, but then, how do you use it ... I thought that while we are talking about problem types, it might be a good time to do it. *(February 15)*

> Faculty B: You've gotta get kids to talk before you can listen. That's the first step and then you listen, but you listen on an individual basis and a whole-class basis. So we need to be sure [preservice teachers] have some techniques for listening in both kinds of environments. And the next step is that they use what they hear the children saying, planning instruction. That's the hard part. *(March 1)*

> Faculty A: It troubles me that we are not able to do yet what ... we are asking CGI teachers to do.
> Faculty B: Let's use [Student B1's] example.... I don't know what the time lapse was from the time I saw her problem until when I brought the group back together again, but that would have been a good time to say [to her], "here is another problem. How would you solve this problem?" And right there given her something to do or take home and work on it.
> Faculty A: But you could view what you did for her, which was to make another drawing, as a way of adapting the problem to fit where you thought she was.
> Faculty B: Right. So there is some individualization. *(April 12)*

> Faculty B: One of my goals [in this session] was to help them see at this point in their program of study, that they do have some competencies that maybe they don't recognize they have ... and try to put some of all we have been learning this semester in a little better perspective for them as a future teacher. *(April 19)*

The statements listed below were provided by the preservice teachers as strong points of the course. It appears that for many students, Faculty B's overall instructional goal of helping them focus on children's thinking as a means for planning appropriate instruction was met.

> Learning how to assess where a child is mathematically and building on that knowledge.
> Making us become kids again to see how they think.
> Use of manipulatives and knowledge of how to assess a child's learning
> To learn how to assess the student's thinking
> The ability to look at students' mathematical ability
> It helps one to think about teaching in a different way.

The strongest points were the Individual Assessment & Group Teaching exercises. I learned the most by actually performing these activities and then analyzing the video tape.
The course really got me to think about the importance of understanding children's thinking.
She emphasizes the children's thinking!
The examples she gave and her knowledge of subject area was [sic] excellent. [She] knows and has an excellent knowledge of math and how students think.
I learned a lot on how to evaluate students' thinking!

Yet, not spending enough time on "how" to teach problems was cited by some students as a weak point in the course. In general, it appeared that this concern was linked to how they were taught since their mathematical background included learning "steps."

Not enough knowledge of how to teach problems--how can you teach problems that we were taught steps to. I don't feel there was enough time spent on this!

Despite Faculty B's goal of building instruction based on children's thinking, the degree to which the preservice teachers were able to make the connection between listening to children and making informed instructional decisions remains unclear. The preservice teachers had only one opportunity during the course to plan and implement a mathematics lesson in their internship classroom. While a videotape of the lesson was submitted as a course requirement, it was not included as part of the data in this study and would have provided limited information about the preservice teacher's instructional planning. The students in Faculty B's class did observe two "demonstration" mathematics lessons during the semester in elementary classrooms as part of the course. Faculty B taught a lesson as a guest teacher in a fifth- grade classroom and an experienced CGI first-grade teacher taught the second lesson in her own classroom. Each of these observations included follow-up discussions on what was learned about children's thinking as a result of the lesson, but the discussion of what would be planned next based on what was learned about students during the lesson, was extremely limited. Several students did indicate in their course evaluations that the course should be changed to include more of this type of experience.

Preservice teachers' thinking and understanding. Many of the interview discussions about Faculty B's teaching often included references to "surprises" concerning the thinking and understanding of the different preservice teachers. It appeared that students made statements and asked questions that had not been expressed by preservice teachers in previous methods courses. It also appeared that, for Faculty B, gaining information about preservice teachers' thinking is limited by the structure and nature of a methods course.

Faculty A: You were intrigued by their solution strategies today and by their use of materials. They used materials in ways that are very different than we see children using materials on tapes.

Faculty B: I think that's what intrigued me. I wasn't expecting that.
Faculty A: To what extent does their experience today with these non-kid-like uses of materials influence what they believe about how materials ought to be used with kids?
Faculty B: I think that is one of those things that I don't have a good feeling about ... because I'm not sure they got much out of that except they had to solve the problems themselves and use materials in [a] different ... way. So it only helped them with their own thinking. But now, they are [to be] thinking as a teacher working with ... children.
Faculty A: Is there the danger that they would think kids would do the same things that they were doing or is there a danger that they might have left the class believing that what they saw their colleagues doing is what kids ought to be doing?
Faculty B: I don't know... I was surprised when [Student B2] said, "Well, after all of that, I'd say, "Here's an easier way to do it." He was listening ... but he was still locked into his own way which was an easier way to do it. *(February 15)*

Faculty A: There were several instances today where your students said things like, I would give them information or I would show them the strategy ... do you think that the students at this stage in the course are not movable from that view or is that view okay with you or is that an issue about the teacher's role that you think needs more discussion or have you discussed it enough that there is no point in discussing it any more right now?
Faculty B: I remember ... at one point saying that "I have been hearing a lot of 'I would show them' and 'I would model them'" and ... [we did] talk about it.
Faculty A: Yes, you did....
Faculty B: It's one of the first times with this group that they have really had a chance to share some of their own mathematical thinking. It's all been, prior to this, more of "how to" as a teacher ... "what it is that [we] need to know in order to teach the children." *(February 15)*

Faculty B: The other thing that [the preservice teachers] were open about today was that they are trying to "get into" their own knowledge base and ... what mathematics is to them and a lot of them are learning new things themselves at the same time: new strategies, new ways of looking at problems.... They are really locked into that basic algorithm and to realize that there are other strategies or ways of solving problems, that's new to them.
Faculty A: I think one of the most revealing questions was, "Is it wrong to teach the traditional way?" .... And I am sure [Student B3] is not the only one that has that question.
Faculty B: [Student B3] talked with me briefly about it during break, but it was more from an apologetic standpoint. And I said, "No, don't apologize. This is what it's all about and you have to raise questions like this for the purpose of extending your own knowledge." *(March 1)*

Faculty B: One thing that totally surprised me was [Student B1]... In answer to the problem of who got more pizza, 3 children with 2 pizzas or 6 children with 4 pizzas, she had it drawn out with 2 pizzas divided into thirds, had darkened in 1/3 in each of the 2 pizzas, had 4 pizzas divided into 6 equal parts, had one part of each one darkened in, and said that they got a bigger piece with 2 pizzas.... She said ... when you combine together the 4 pieces in the 4 pizzas, it equals one of these pieces up here at the top. But, they had 2 pizzas so they get 2 pieces, so therefore they get more.

Faculty A: Why did that surprise you?
Faculty B: I wasn't expecting a college student to make that kind of mistake.
Faculty A: Did you have a chance to ask her anything else after she had seen the tapes of the children [and how they solved it]?
Faculty B: No. I probed as I was there at the table working with her.
Faculty A: Do you have any idea whether her thinking originally was abstract or visual or symbol manipulative or some other approach.
Faculty B: I really don't know and that's the one problem I see with college courses. You want to probe further and you can't do it at that moment.... I am going to have to establish a situation where I can learn ... more about her thinking in isolation of the rest of the group.... That would have been a [time] to talk about that you can learn a lot from wrong answers and that we don't probe wrong answers enough. *(April 12)*

The consensus between Faculty A and Faculty B was that the difference in the amount of student statements and questions compared with that which Faculty B had experienced in former methods courses was due, in part, to the changes Faculty B was making in her own teaching. She was asking more questions as a result of the change to a constructivist orientation and she had greater interest in gaining more understanding of the preservice teachers' thinking.

Wait and talk time. An important factor that appeared to be related to Faculty B's overall goal of providing the preservice teachers with first-hand experiences that "modeled" constructivism and the principles of CGI were the amount of "wait" and talk time available to students.

Faculty A: After the break, it seemed to me that the wait time was much longer.
Faculty B: I didn't even think about my wait time whatsoever and ... I was going to focus more on what I was doing; how it compared with pedagogy versus [mathematics content] discussions.
Faculty A: There were no mathematical problems today so I couldn't make that comparison, but the discussion of the video tapes and in the initial discussion of the assessments, the questions were very rapidly fired in both directions, that is, almost no time at all between questions. After the break, when you started talking about the [videotape of the first-grade math lesson], there seemed to me to be longer time, longer pauses.... My observation is that in the first half, before break, you asked for clarification of student responses in the middle of the student response, you jumped in with a probing question in the middle of a response, and you jumped from student to student very quickly. In the second half ... maybe because you called on some people who had not been contributors, you asked a question and you waited for a response and you let the response play out before you then asked the probing question.
Faculty B: I think part of it might be I felt more comfortable [in the second half] because I was in control.... I knew what I wanted to do and I knew that I could have more control over that. But I also wanted to get more people involved ... [in] the first part I didn't know where ... we were going.
Faculty A: I'll suggest another possible interpretation.... The first half you came in with a lesson plan and, as you have said earlier in our discussion, it got destroyed. And I wonder if you were trying to pull the class back or feeling pressure that you needed to get back to your lesson plan, but during break

you made a decision about what you were going to do with the rest of the time and so you forgot about the part of the lesson plan that you were not going to cover because you had already decided during break, "I can't cover that today." So you let go.
Faculty B: I actually decided it prior to break. That's probably a good point. (March 1)

Faculty B: I feel more comfortable talking about children and observing children than I do extending their ... content knowledge
Faculty A: Okay. And that may be an important thing for you to reflect on.
Faculty B: I wasn't sure what their own understanding was ... and I wanted to find out, and I had to have them talk more than I talked. That's why I changed in the middle. *(April 12)*

Faculty B's comfort level seemed higher when focusing on pedagogical knowledge than it did when focusing on some areas of mathematics content. Student evaluations for the course did not include any citations relative to this area of concern for Faculty A and Faculty B.

Lack of instructional models in internship settings. It appeared to Faculty B that the lack of opportunity for the preservice teachers to observe mathematics being taught the way that was being advocated during the methods course was problematic.

Faculty B: Today's lesson was very informative for me.... It wasn't at all what I had planned for, but it's very clear what effects there can be ... based on somebody's traditional background ... and then what they are seeing in the school and having trouble making what they are hearing in the [methods course] fit into that whole big picture. *(March 1)*

Based on the student evaluation data, it appears that some preservice teachers shared Faculty B's concern.

Sometimes I feel a lack in knowledge of teaching math because CGI examples received in class might not be compatible with what's in real life
Not enough field trips--see actual implementation of CGI methods

Finally, evaluative feedback for changes which Faculty B could make in the course included items that did not come up during the interview discussion. Although detailed directions concerning requirements were provided as part of the syllabus, several students needed more discussion concerning what was expected.

We didn't have any verbal directions on assignments. We were only given assignments on paper.
Grading criteria unclear and objectives somewhat clear.
Assignments in the course were beneficial but the expectations of what need to be included in the assignments needs to be more clear.

Faculty B: Discussion

It appears that Faculty B met her overall goal for the course. The preservice teachers appeared to value the need to focus on children's thinking as a major component of mathematics education in the elementary school. Yet, to achieve this more effectively, the mathematics instruction being observed during the preservice teachers' internships, needs to be more aligned with what is being learned in the methods course. Based on the student evaluation data, Faculty B, needs to provide more explicit verbal directions and expectations for course requirements. Although detailed written directions for the various assignments were provided and similar activities were conducted in class to provide students with first-hand experiences and examples, it cannot be assumed that, just because they are preservice teachers, the students in an elementary mathematics methods course will be able to complete assignments without further verbal directions and/or clarification.

Conclusions

Clearly what the faculty viewed as important for effective instruction was not necessarily acknowledged by students as important and in some cases was even identified by students as being counterproductive. The two faculty explicitly tried to make their instruction consistent philosophically with the ways they wanted prospective teachers to teach. Yet, many of the prospective teachers did not acknowledge that model as appropriate for teaching children. The prospective teachers seemed to expect an instruction model in which the teacher was the mathematics authority in the classroom.

The "filter" through which the faculty viewed mathematics instruction in the methods course seemed to prevent their identification of some of the things that students thought were important about instruction in that course. In particular, students did not share the same recognition as the faculty of the importance of understanding what children know about mathematical problem solving. A more encompassing filter might help the faculty to understand the students' perspectives on instruction in the methods course.

The faculty may need to communicate their goals and objectives more explicitly to students. As Stengel and Tom (1996) pointed out, it is important for all parties in a course to understand each other and to feel that they are being represented in the substance of the course. Faculty and students need to share their goals so that each knows what the other is about.

The faculty did not learn as much about the students' thinking as they had originally hoped. Perhaps this was because the class met with them only once a week, so repeated, long-term interactions were difficult to develop and sustain. Perhaps it was because the tasks set for the students were not ones that revealed their thinking clearly. Perhaps it was because faculty were looking for levels of thinking about content and pedagogy that the students could not

demonstrate. Perhaps it was because the students did not understand the importance of sharing their thinking, so they were reluctant to do so.

There are a number of confounding factors in this study. First, the different genders of the instructors may have had an impact. In a study of over 5,000 college students over four years, Basow (1995) found that female students seem to prefer women's teaching styles and rate female instructors more highly than male instructors. Our data do not allow us even to speculate on whether this finding might be applicable in our setting. Second, Faculty B's greater "surface validity" as an experienced, full-time elementary teacher may have impacted her students' evaluations of her and of her instruction. Because she was the team leader for her students, she could also easily arrange to teach a demonstration lesson with elementary school children. Third, Faculty B had much greater interaction with her students outside of the setting of the methods course. She also held power over her students (in the guise of giving them grades in other courses), and all students knew that she would be the supervising professor during student teaching in the year following completion of the methods course.

The data of this study seem clearly to point out that faculty's having a coherent vision of instruction is not sufficient to impact the learning of students. That vision must at least be communicated to students, and more likely, it must probably be modified to adapt to the vision of instruction that the majority of students bring to the course. Without sharing of perspectives, students and faculty seem to talk past each other so that neither party gains a full understanding of what the other party is about.

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